

Digital Twins and Standards:

A review of the consultation launched for the UK digital twin program

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VISIT...

LANZAROTE
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My introduction

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- Standards consultant at BSI advising government and industry on standards to support policy and business objectives
 - Digital Infrastructures
 - Smart Cities
 - Energy and Environmental Systems
 - Distributed energy
- Inspire expert (technical guideline development)
 - Marine and atmosphere
- Supported Copernicus and EMODNET development
- Standards development BSI IST/36 (UK ISO TC211 mirror)

This presentation represents my own views and not those of BSI 😊

What's driving digital twins in the UK?



- “Data for the Public Good” published by the UK National Infrastructure Commission
- Report set out a vision and challenge of a National Digital Twin: a Digital Twin of National Infrastructure
- To provide information supporting improved decision taking by those developing, operating, maintaining and using infrastructure and the services they provide to citizens.

“Taking BIM beyond the construction phase”

Digital twin implementation in the UK



<https://www.cdbb.cam.ac.uk/>

Digital technology is changing the way we plan, build, maintain and use our social and economic infrastructure. Building Information Modelling (BIM) is already transforming the UK construction industry, using information management processes to gain efficiencies in the design and construction processes.

*Over the next decade this technology will combine with digital twins and the Internet of Things – sensors, advanced data analytics, data-driven manufacturing and the digital economy – **enabling us to plan infrastructure more effectively, to build it at lower cost and to operate and maintain it for better performance over a longer lifespan.***

Open consultation

- The Centre for Digital Built Britain's National Digital Twin (NDT) programme has launched an [open consultation](#) seeking feedback on the proposed approach to the development of an Information Management Framework for the built environment.
- <https://www.cdbb.cam.ac.uk/news/pathway-towards-IMF>
- Consultation 01/06/2020 - 31/08/2020



The vision of a Digital Built Britain (Sec 2.1)

“The National Digital Twin is an ecosystem of digital twins and the protocols by which they can be integrated securely and resiliently.”

“The NDT will not be a large, single model of the entire built and natural environment. Instead, it will consist of multiple consistent digital twins”

“An NDT therefore requires information to be compatible across the built and natural environment, presented in consistent formats to allow for sharing and integration between different digital twins.”

“This will need us to move beyond data exchange to data sharing and integration.”

“It will also demand interventions to enable curation and mapping of existing and future models and data.”

“However, beneath the surface, it will require major work to make it a reality. This will need up-front work to create the shared understanding, reference data and common data models”

The consultation document

What is good

- ↑ Its easy to understand the vision and implementation pathway
- ↑ An end to end pathway is presented from 'where we are now' to 'end vision'
- ↑ Comprehensive scope
- ↑ Its not that radical; reinforces conclusions from experience to date

What is not so good

- ↓ Says DT's are more than 'just infrastructure' but narrative is very 'asset focussed'
- ↓ Academic focus; 'research into DT's' rather than 'implementing DT's'
- ↓ Imprecise and lacking in detail; makes responding difficult
- ↓ Limited examples of current practice suggest DT is a 'greenfield' activity

Standards communities meeting in the middle



Smart Cities

- High level, aspirational big picture
- Moving from abstract to application

BIM

- Application focussed
- Extending the scope into the bigger picture



And the communities over the fence.....

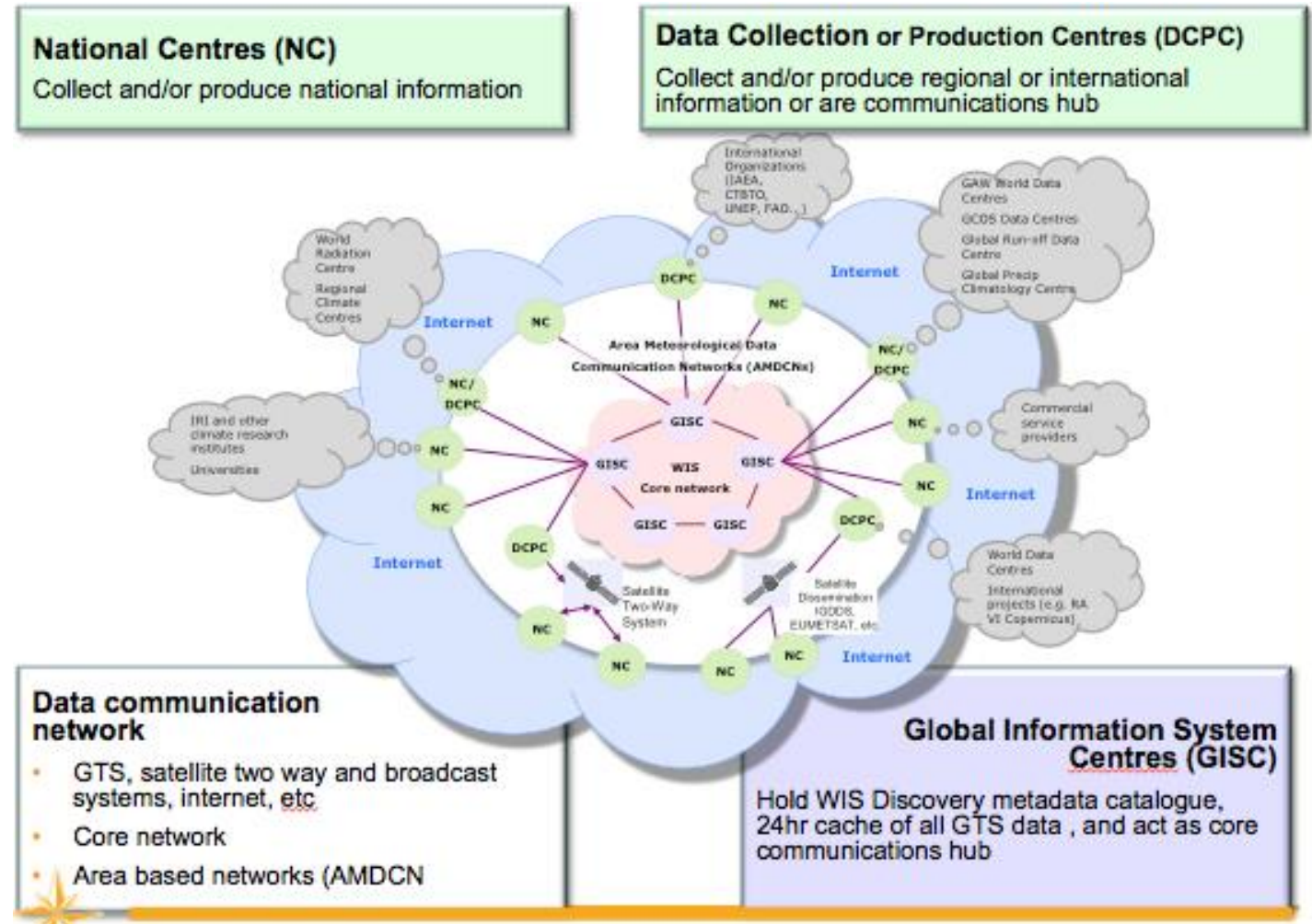
- Mapping
- Industrial automation
- Meteorology
- Oceanology

These communities are often referred to in plans for developing DT's 'as something new' - already have mature digital twin operations/precursors, built up over decades

World meteorological systems



- Global network of observations and numerical simulations under the auspices of the United Nations
- Operating across different domains: weather, climate, ocean, atmosphere
- Operating at the local, national and international
- First numerical weather prediction in 1922



Copernicus



- Integrated network of data services based on Earth Observation data
- Operating across different domains: land, climate, security, emergency ocean, atmosphere
- Numerical processing of remote observations with operational ground truth
- Alignment with WMO operations
- First operations in 1998

Copernicus Climate Change Services

Climate change

Mitigation and adaptation

Weather forecast

Pollution

Environment

Health

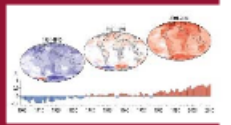
Consistent Estimates of the Essential Climate Variables (ECVs)



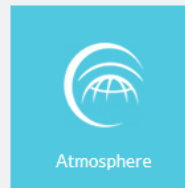
Support to Mitigation and Adaptation Strategies



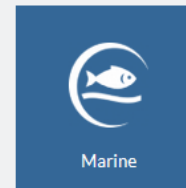
Global and Regional Reanalyses



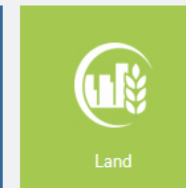
Seasonal Forecasts And Climate Projections



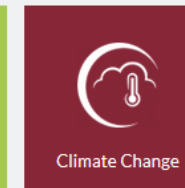
Atmosphere



Marine



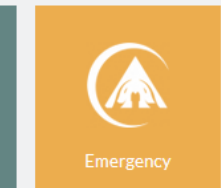
Land



Climate Change



Security



Emergency

Inspire

- International framework for data harmonization and exchange under the auspices of the EU
- Standards based approach to coordinate established community approaches
- Supports coordinated discovery, view and download of datasets



Annex I



Annex II



Annex III



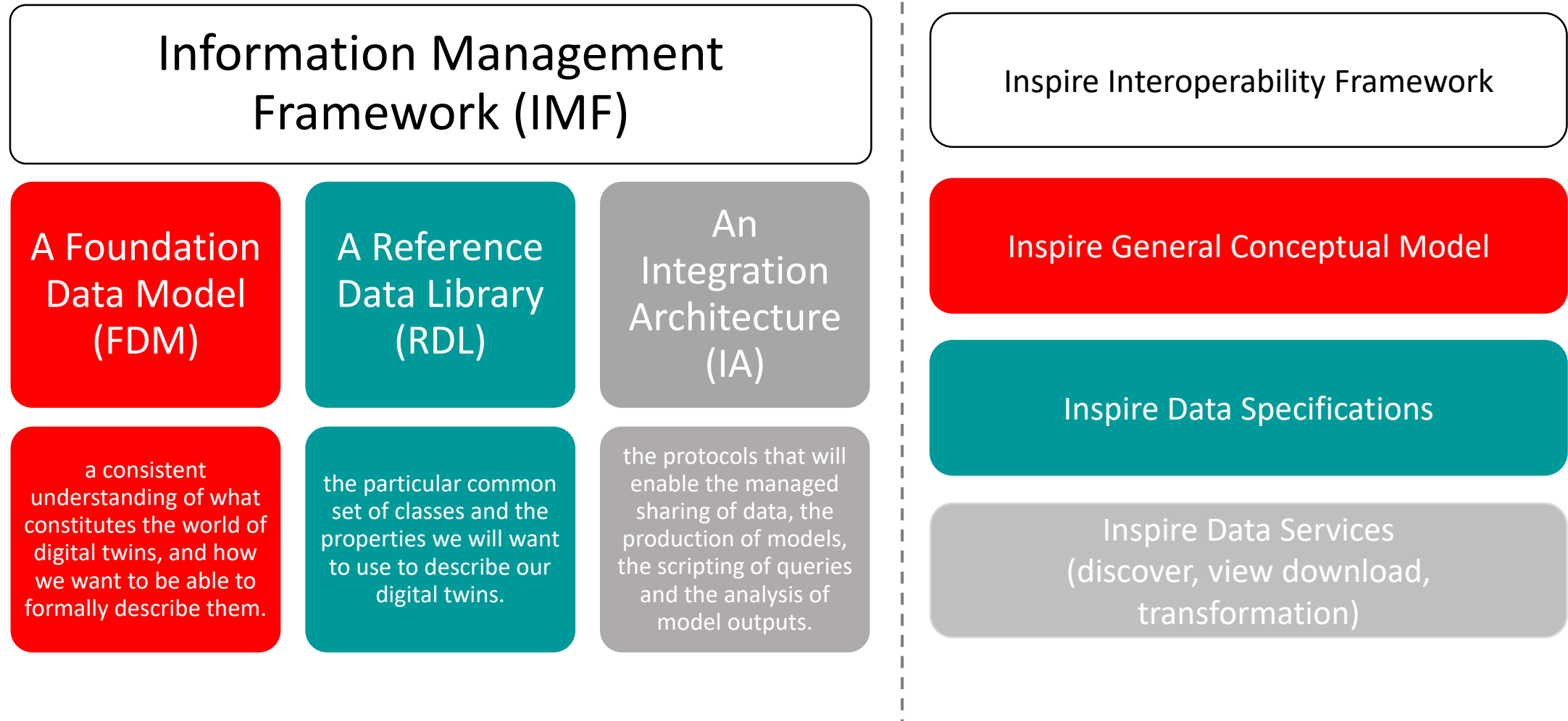
<http://inspire.ec.europa.eu/index.cfm/pageid/2/list/7>

“The approach taken by inspire to support cross-domain data harmonization should support DT development”

The UK NDT consultation questions are:

1. It has been proposed that the Information Management Framework (IMF) should essentially consist of a Foundation Data Model (FDM), a Reference Data Library (RDL) and an Integration Architecture (IA). Do you agree with this overall framework? In your view, are there any key elements missing from this framework?
2. Section 3.4 lists the models and protocols that would form part of the **Information Management Framework (IMF)**. Is there anything that you would like to suggest to improve this list?
3. Section 3.5 describes key concepts of a **Foundation Data Model (FDM)**. Is there anything that you would like to suggest to improve this description?
4. Section 3.6 describes key concepts of the **Reference Data Library (RDL)**. Is there anything that you would like to suggest to improve this description?
5. Section 3.7 describes key concepts of an **Integration Architecture (IA)**. Is there anything that you would like to suggest to improve this description?
6. What do you see as the barriers to connecting digital twins within organisations and between different organisations/sectors? How can these barriers be overcome?
7. In your experience what are the reasons why organisations invest in the creation of digital twins? Why would they invest in connecting digital twins?

UK digital twin approach v Inspire



Consultation Section 3.4. IMF Scope

- ✓ **Interoperable models and standards for structuring data** across the built environment, and the ability either to automatically extract and transform data into such a consistent form, or to update local data sources into consistent formats.
- ✓ A data model that **extends beyond the purely physical/functional representation** to address attributes related to the legal, regulatory, societal, ethical and temporal contexts within which the assets operate or may be required to operate.
- ✓ Integrated asset and configuration management to manage the **spatial and temporal (and other) changes** over the physical asset's life cycle.
- ✓ Protocols for abstracting services, including those that provide real-time streaming data, and also those services that allow us to **execute the models and resolve the queries needed** to be able to ask questions of digital twins.
- ✓ Protocols for **managing the distribution of outputs** from queries or model resolution such that they can be used as inputs in further queries in consistent and automated (or, where that is not achievable, semi-automated) ways.
- ✓ Approaches for **deploying digital twins onto computational infrastructure**, perhaps cloud-based, upon demand, and scaling capability when required.
- ✓ Protocols for managing, **securing and controlling access to information**: which actors, in which roles, can access which data sets and invoke which models?
- ✓ **Information management and governance policies** and processes that support integrated asset and configuration management so as to maintain coherence between the digital and physical elements of a twin and enabling integration of cross-domain twins.



“Agree all these factors need to be considered as part of the IMF. There may well be over factors, but this a good starting point. There is good practice from Inspire and WMO operations that can be considered “

Consultation Section 3.5 FDM Scope

- Time, space does the ontology deal with places, locations, shape, holes and a vacuum?
- Actuality and possibility: How does the ontology deal with what could have been the case, such as with multiple data sets and conflicting stories of a network?
- Classes and types: How does the ontology deal with issues of classification?
- Time and change: How does the ontology deal with time and change?
- Parts, wholes, unity and boundaries: How does the ontology deal with relationships, parthood?
- Scale and granularity: How does the ontology deal with scale, resolution?
- Qualities and quantitative attributes: How does the ontology deal with qualities and quantitative attributes?
- Quantities and mathematical data and theories: How does the ontology deal with quantities and mathematical data and theories?
- Processes and events: How does the ontology deal with processes?
- Constitution: How does the ontology deal with constitution? – between material entities and the material they are made of?
- Causality: How does the ontology deal with causality?
- Information and reference: How does the ontology deal with information and reference?
- Artefacts and entities: How does the ontology deal with artefacts and entities (e.g. engineered items) and socially constructed items like money and law?

Example Identified Challenges (

- **How do we define the non-p**
describing the mathematical
a grid resolution?

- **How do we aggregate model**
very different tempos – from
days?

- **How do we make statements**
do I talk about discrete time
Thursdays” or “in Summer” c

- **do we describe and capture c**

Existing deployments have face
questions and come up with an



INSPIRE
Infrastructure for Spatial Information in Europe

INSPIRE Generic Conceptual Model

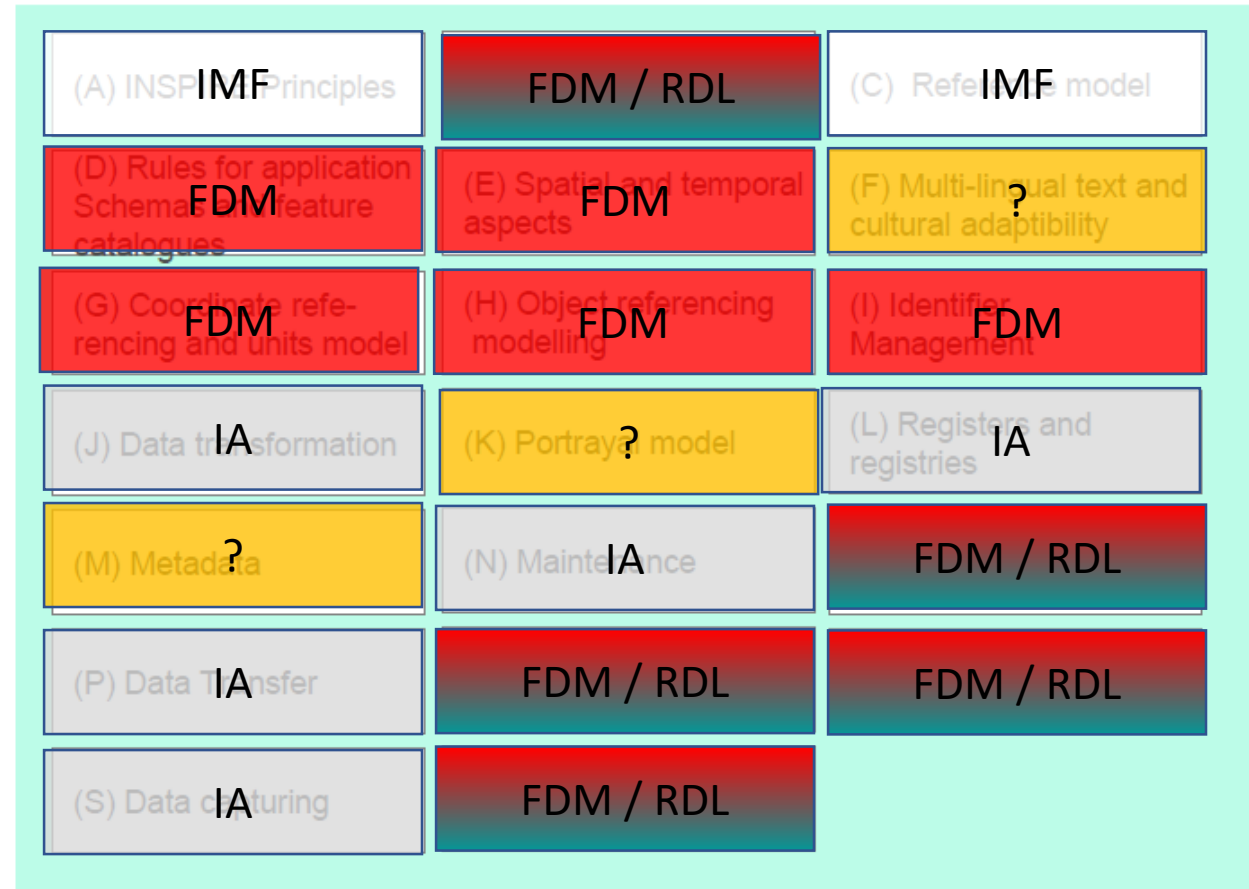
Title	D2.5: Generic Conceptual Model, Version 3.4rc3
Status	Version for Annex II/III data specifications v3.0rc3
Creator	Drafting Team "Data Specifications"
Date	2013-04-05
Subject	Generic Conceptual Model of the INSPIRE data specifications
Publisher	Drafting Team "Data Specifications"
Type	Text
Description	Generic Conceptual Model of the INSPIRE data specifications
Contributor	Members of the INSPIRE Drafting Team "Data Specifications", INSPIRE Spatial Data Interest Communities & Legally Mandated Organisations, INSPIRE Consolidation Teams and other Drafting Teams
Format	Portable document format (pdf)
Source	Drafting Team "Data Specifications"
Rights	Public

Consultation Section 3.5 FDM Scope

Cross-comparison with Inspire

- Time, space and place
- Actuality and possibility
- Classes and types
- Time and change:
- Parts, wholes, unity and boundaries:
- Scale and granularity
- Qualities and other attributes
- Quantities and mathematical entities
- Processes and events
- Constitution of objects
- Causality relationships
- Information and reference:
- Artefacts and socially constructed entities

FDM Scope



Inspire: Data interoperability components – overview

Consultation Section 3.6 RDL Scope

Cross-comparison with Inspire

“Agree the approach for a RDL that provides for domain specific application based on the rules of the FDM. Question whether external foundation schema are part of the FDM or wider IMF”

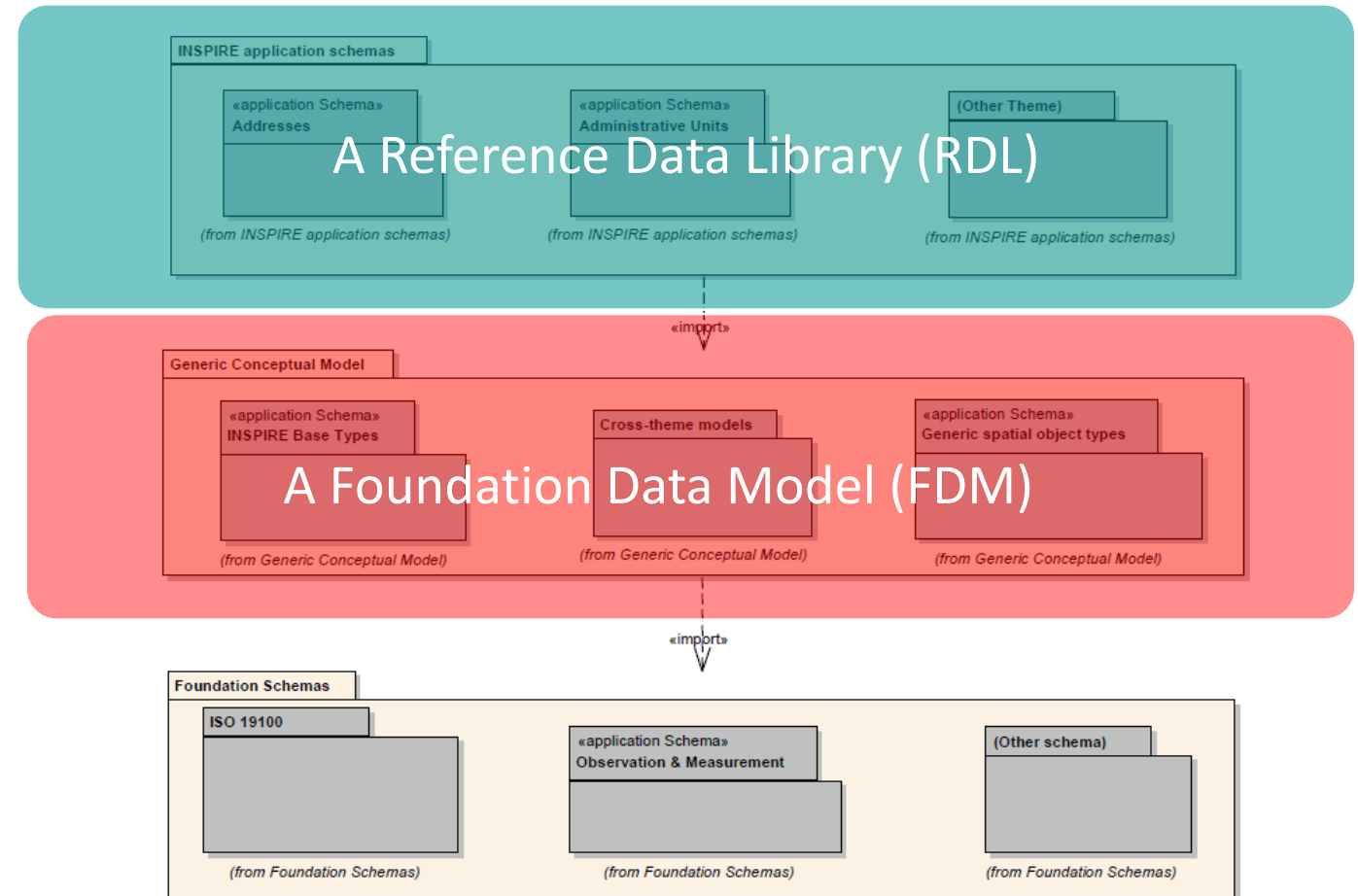


Figure 3 – The Generic Conceptual Model as the basis for INSPIRE application schemas

In summary



- A consultation has been launched on the pathway to develop an information management framework for a UK National Digital Twin
- The elements and components of the IMF proposed appear consistent with those in communities undertaking related or similar activities.
 - It is surprising that internationally established practices are not cited as evidence to justify the proposed pathway in any detail.
- The report is comprehensive, but imprecise so although there is nothing wrong with the approach, it is not possible to comment if the pathway will be successful .
- <https://www.cdbb.cam.ac.uk/news/pathway-towards-IMF>
- Consultation 01/06/2020 - 31/08/2020